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No. 3. **Part 4.**

THE OUTBREAKS OF RINDERPEST

IN

SELANGOR, 1903 & 1904.

BY

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The Outbreaks of Rinderpest in Selangor in 1903 and 1904.

No addition has been made to the knowledge of the causation of Rinderpest or of the organism producing it, but the course of the outbreaks, the conditions under which it spreads and the relative susceptibilities of various breeds of animals are points of interest.

I have confined my accounts to those of the outbreaks in Selangor as these I was able to follow. From the information placed at my disposal as regarding outbreaks elsewhere I conclude that in the main the conditions were similar and the main conclusions I draw are essentially similar to those on which previous action by the Government Veterinary Surgeons, Messrs. Moir and Ford, has been based in the past.

Epidemics have been numerous and destructive in the past, and for some time a doubt had been entertained by some as to whether the disease was Rinderpest or Hæmorrhagic Septicæmia. This doubt was sufficient to discourage attempts at serum treatment in any form. A series of attempts to locally prepare a serum did not give sufficiently satisfactory results to be conclusive to others of its value or to render its adoption general.

It is necessary before considering the disease to mention the main breeds of cattle in the Peninsula, but crosses are common. There are five main breeds, Siamese, Indian and Bali bullocks and Malay and Indian buffaloes.

1. Siamese cattle are small sturdy beasts standing about 12 hands and weighing about 500 lbs. The horns are short and slightly curved so as to point upwards and forwards. They diverge widely. In colour they are yellow or brown, and a smaller variety, Kedah cattle, are black. They are rarely if ever white. The skin and hair in texture resemble that of English breeds.

2. Indian cattle are larger animals standing sometimes up to 14 hands and weighing up to 700 lbs. The horns are long and curve backwards or forwards. They diverge little. They are frequently white, but may be dark brown, or mottled, and are rarely yellow. They usually show some indication of a hump.

These breeds cross freely.

3. The Bali bullock has not been imported into the country except for beef. The original breed is not known, but it has been crossed with the Borneo Sladang, *Bos sundinacus*, and shows the markings and has the shape of that animal.

4. The Malay buffalo, Cariboo (Malay Kerbau), is a water buffalo and stands some 13 hands and weighs up to 1,000 lbs. They are powerful beasts and used for heavy and jungle work by the Malays chiefly. The horns are long, slightly curved upwards, and project from each side of the head laterally. For two-thirds of their length they are ridged transversely. With the heads extended, as when charging, the horns and upper part of the neck are nearly in the same plane. They are usually a dirty black colour with a sparse covering of coarse hair. They may, however, be white.

5. The Indian water buffalo is a different shaped animal, and is easily recognised by the twisted and curled horn which usually curves irregularly backwards. They are imported mainly for milk, and are the breed known in India as Delhi buffaloes.

These distinctions of breed are of great importance as the susceptibility differs greatly and the course of the disease differs according to breed. Some breeds, such as the Malay buffalo, suffer most severely, others, as the bullocks, are the active agents in spreading the disease though they do not suffer so severely.

The Malay buffalo is by far the most susceptible and the Indian buffalo the least. In an epidemic in any group all or nearly all the Malay buffaloes are attacked and only the calves and a few adults of the Indian buffaloes.

The mortality is greatest amongst the Malay buffaloes; 85 per cent. case mortality for these is low. Amongst the Siamese cattle there is considerable variation, but on the average about half the cases recover and a rather larger proportion of the better class of Indian cattle. About 25 per cent. of the Indian buffalo calves die, but few of the full grown buffaloes.

The Bali bullocks are susceptible and all attacked have died, but the numbers observed are too small for comparative purposes.

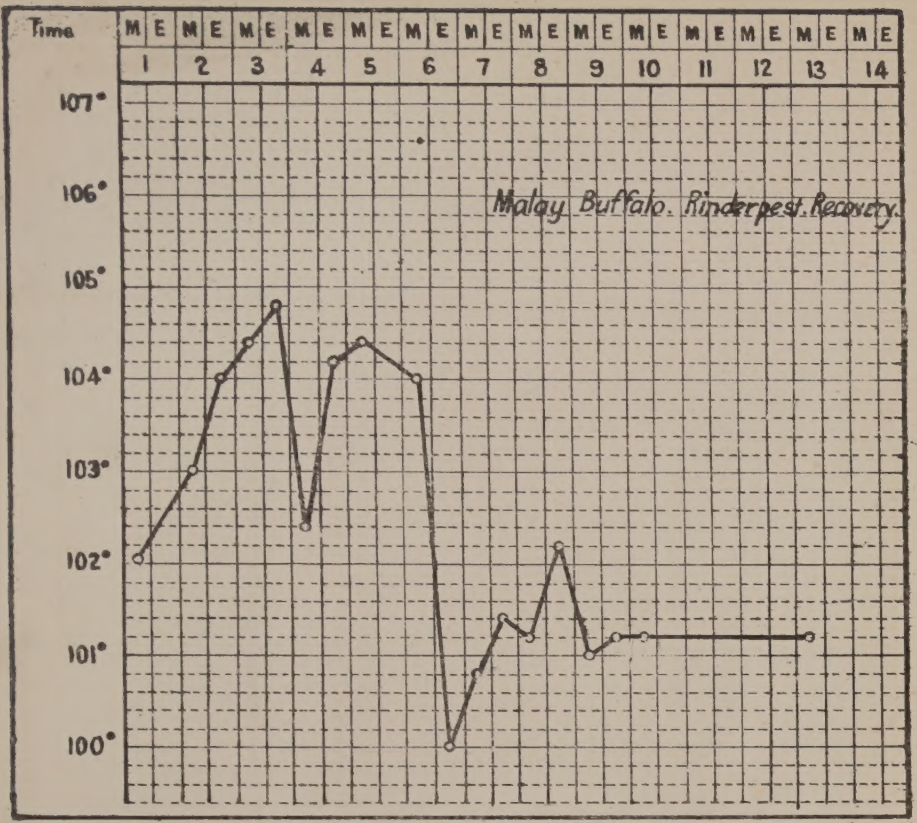
The Course of the Disease.—As this varies greatly it is simpler to describe first the severe form, that seen in Malay buffaloes, in detail, and then consider the differences in the other breeds of cattle.

Period of Incubation.—This is well known to be from inoculation a period 3 to 4 days. Infection in a natural manner is more difficult to ascertain, but appears to be less regular. The actual date of onset as determined by onset of characteristic symptoms is often not definite, but, though only shown at first by a rise of temperature, is really sudden.

From several series in which the temperature of all animals was taken daily the period of incubation appears to be usually 4 to 6 days but may be as long as 8. In buffaloes 5 days seems to be the common period. It is highly exceptional for the first attack as indicated by the rise of temperature to occur amongst a group of contacts 7 days after removal from the source of infection. The animal may not appear to be ill for two or more days after this and may even be able to work for 4 days or more, and in such cases, as the early stages are overlooked, the period of incubation will appear to be longer. This is more often the case with bullocks. The buffalo usually is obviously ill 24 to 36 hours after the onset of the disease.

During the period of incubation the animal appears to be in pertect health.

Onset in the Malay Buffalo.—As tested by the thermometer the onset of the disease is sudden. An animal whose temperature has previously been normal is found to have a temperature over 103 or 104 or even over 105° F. At this stage there may be absolutely no other sign of illness, but more frequently there is some exaggeration of the usual congestion of the conjunctiva, and if motions are passed they will be harder than normal. The animal will still feed and ruminate in a natural manner and does not seem more depressed than a quiescent buffalo usually is. In this early stage even an expert veterinary surgeon used to this buffalo and on the look out for fresh cases may easily overlook such early cases. Symptoms rapidly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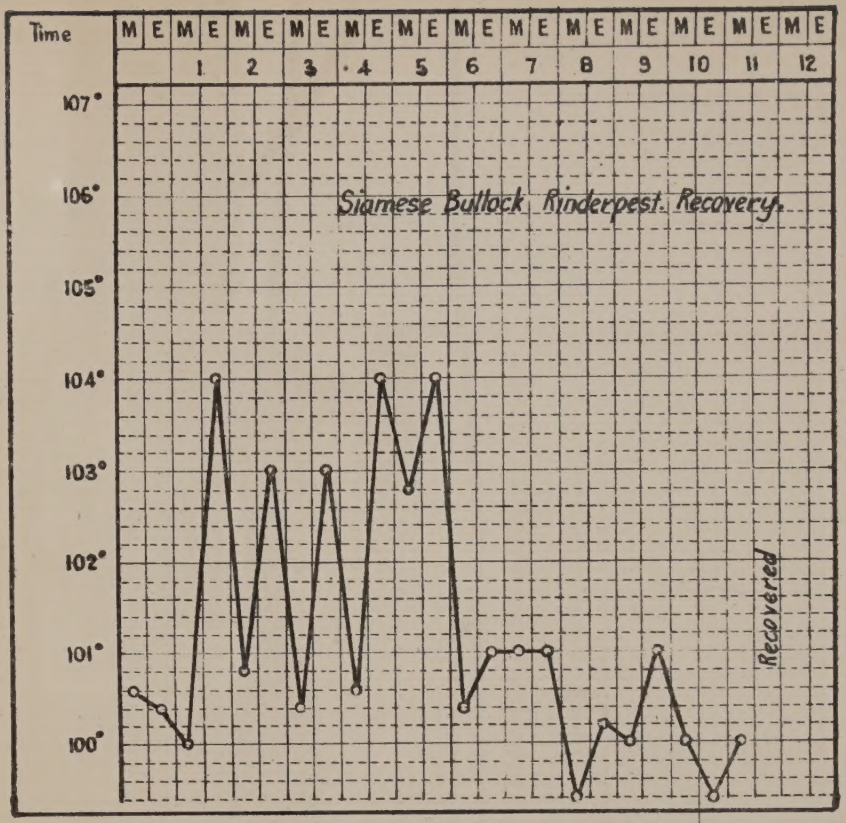
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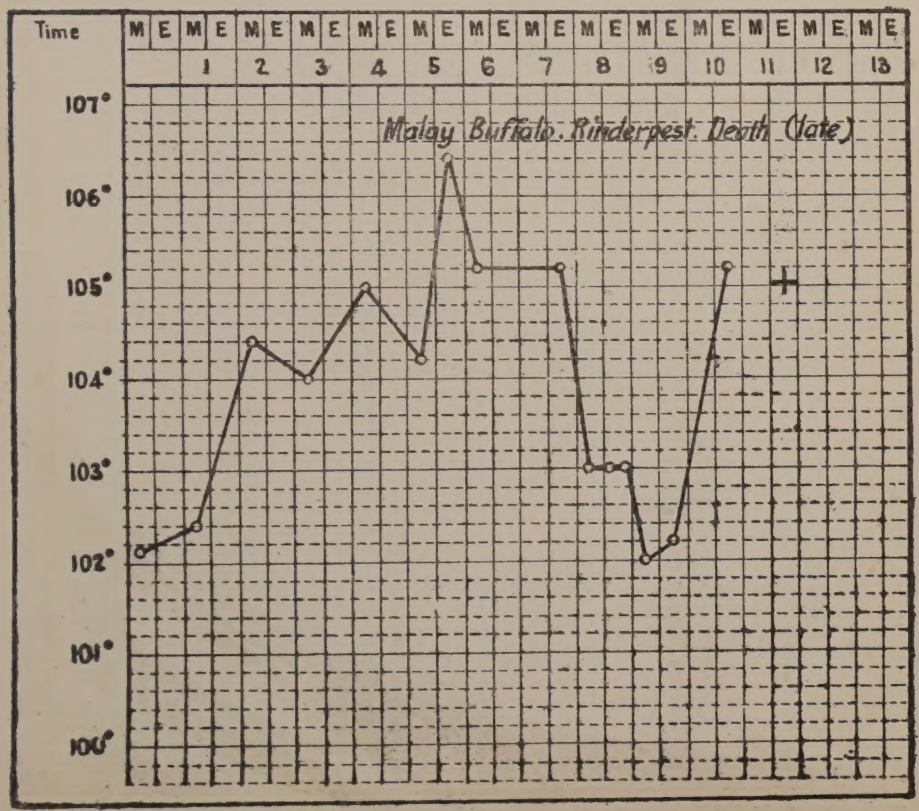
Siamese Bullock Rinderpest. Recovery.
Recovered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Malay Buffalo. Rinderpest. Death (late)
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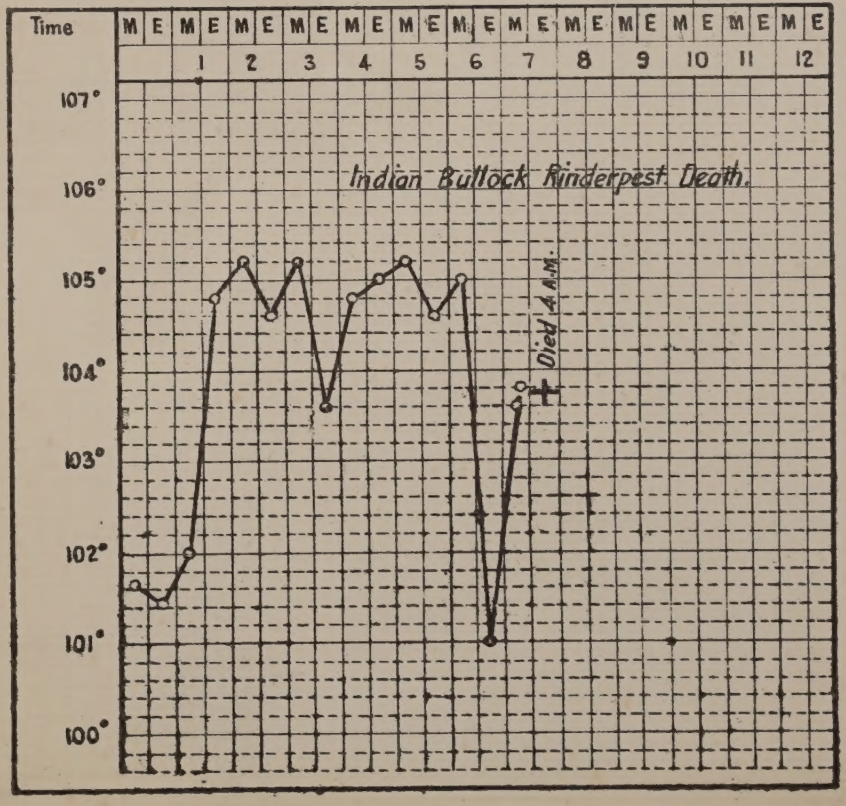
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Indian Bullock Rinderpest. Death.
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supervene, mainly manifestations of gastro-intestinal disease and affections of the visible mucous surfaces. The conjuctiva becomes intensely congested and there is a free watery discharge, which becomes thicker and by the third or fourth day is muco-purulent. There is discharge from the mouth and nose also at first watery but becoming thicker and more muco-purulent, and the mucous membranes of the mouth and nose are congested. On the inner aspect of the lips and especially towards the canthi there are often patches of adherent granular material. On the forcible removal of this layer by rubbing it the mucous membrane beneath is seen to be markedly congested and sometimes excoriated or superficially ulcerated.

The temperature is maintained usually over 104, and there is little or no morning remission.

The animal may feed for the first 24 hours, but the amount of food taken is below the average. After the second day little or no food will be taken and only occasionally will the animal ruminate and then only for brief periods. There is excessive thirst. The animal is obviously depressed and stands with drooping head taking little notice of surroundings. Occasionally the animal may become violently maniacal.

The early stage of constipation rarely lasts for more than 24 hours, and usually some 36 hours after the first rise of temperature diarrhœa sets in and rapidly becomes profuse. The motions are offensive. At first they are loose and watery, but soon are mixed with mucus and mixed or streaked with blood, and may contain flakes or shreds of mucous membrane. In character as the disease advances the motions are more and more dysenteric and are passed with much straining and tenesmus, and often the animal shows obvious signs of abdominal pain.

Death may occur on the fourth day of the disease and is said to occur even on the second or third, but is most usual on the fifth or sixth. The temperature a few hours before death rapidly falls and often becomes subnormal.

The great majority, in some outbreaks practically all, die, but if death does not occur before the eighth day the prognosis becomes much more favourable though deaths do occur amongst animals apparently convalescent up to at least 14 days after the onset of the illness.

In illustration of the extreme susceptibility and the virulence of the disease in Malay buffaloes are the epidemics at Dusun Tua, where 7 animals out of 9 were attacked and all died. At Port Swettenham in the Quarantine Station 24 were attacked and 21 died, or 86 per cent. There were 6 other buffaloes in the shed but these were killed at the rate of two daily for beef before they had time to acquire the disease so that the proportion attacked cannot be definitely ascertained. In the Selangor outbreak the only Malay buffaloes, 8, known to have been in contact with infected bullocks acquired the disease and all died.

Morbid Anatomy.—In addition to the lesions observable during life the post-mortem examination shows extensive implication of the gastro-intestinal tract. In the abdomen there was excess of clear fluid in the peritoneal cavity and usually some recent formation of fibrous lymph. The changes never amounted to acute peritonitis. The mesenteric glands were enlarged and in some cases there were hæmorrhages in them. The pharynx and œsophagus were usually congested. There were no definite lesions in the first three stomachs, but the fourth, the abomasum, was invariably the seat of severe lesions. It was always intensely congested

and showed submucous hæmorrhages varying in size and number in different cases. In some of these cases there was destruction of the mucous membrane over part of the larger of these hæmorrhagic areas forming ulcers, and in other cases there was micro or macroscopic evidence of necrosis. In a few cases there was definite ulceration independently of the hæmorrhagic areas. The vessels leading from these ulcers were in some cases filled with antemortem thrombus.

The duodenum was acutely congested, and the changes in some cases were as acute as in the abomasum and then there was also ulceration.

The small intestines in a slighter degree were more or less congested, but ulceration in any part but the duodenum was highly exceptional. Peyer's patches were not markedly enlarged and in no cases were they ulcerated.

The cæcum and large intestine were preferential sites for acute lesions. The whole course from the Cæcum to the Rectum was congested, and patechiæ and ecchymoses occurred in some cases down the whole extent. These ecchymoses are usually arranged longitudinally down the bowel. The changes were most marked in the majority of cases in the cæcum and rectum. Actual ulceration of the cæcum was not common but in the rectum was present in nearly all cases, and the lesions were marked, extensive, and sometimes deep.

The liver, beyond congestion and cloudy swelling, showed no changes where death occurred in the earlier stages of the disease, but in cases where death occurred later fatty degeneration was found. The gall-bladder was usually distended with bile but in some cases hæmorrhage had taken place into the cavity and in all acute cases the mucous membrane was injected, much congested, and patechiæ or submucous hæmorrhages were present. The changes were not unlike those met with in the abomasum, but ulceration was only seen in two cases.

The spleen was not enlarged. The kidneys were much congested.

The trachea was usually injected and some congestion of the lungs present with extensive emphysematous areas. Subpleural ecchymoses were not uncommon but were rarely extensive or numerous. Definite consolidation of large areas, acute lobar pneumonia, was found in some cases but in so small a proportion that it must be considered as a complication not as part of the disease.

The heart muscles were friable and small patechiæ were sometimes found under either parietal or visceral pericardium and under the endocardium. No subcutaneous or intramuscular hæmorrhages were found, and no signs of suppuration or localised swellings either in the tissues of the neck or elsewhere.

The above description applies only to the Malay buffalo, and it applies equally to cases in which the infection was derived from bullocks and from other Malay buffaloes.

In Siamese and Indian cattle the disease runs a milder course and in fatal cases the lesions are less severe. So great is the difference that, except for the communicability of the disease from cattle to buffaloes and vice versa, doubt might be entertained as to the identity of the disease.

The period of incubation is much the same but early cases are very rare and 6 or 7 days is the more usual period. The duration is less certain than in the Malay buffalo for the sudden rise of temperature marking the onset though usual is not always present, and the marked symptoms are often delayed in their appearance to the fourth or fifth day after the onset of the disease.

The differences in the course of the disease in addition to the slower appearance of symptoms, the later period of deaths and the smaller mortality, are that the conjunctival congestion and the discharges from the conjunctiva mouth and nose are much less. They may be scanty or even absent. Diarrhœa does not often set in till the third day and in some cases may not occur to a marked extent at all. The diarrhœa does not so rapidly become dysenteric and may not become so at all or may only remain so for one or two days. The animal frequently, even in a fatal case, will feed and ruminate till the fourth day.

The course of the disease as shown by the temperature in most cases is fairly regular. There is a sudden rise of temperature perhaps to 104 or over, and the temperature remains high, but usually with some morning intermission, for 6 days, when it falls rapidly, and in cases of recovery though it may be irregular for a few days there is a rapid improvement in the condition of the animal which in the course of a day or two will begin to feed, to pass firmer motions, and to resume its normal aspect.

In an unfavourable case the temperature after about the same period, 6 to 7 days, may fall to subnormal and the animal die collapsed, or may remain high or even become higher and the animal die within 24 hours. In other cases though the temperature falls in a natural manner and does not rise much again the symptoms are only partly relieved, the animal will not feed, and dies in 3 or 4 days.

The course in Siamese and Indian cattles is much the same but the mortality is greater in the Siamese. In the Selangor outbreaks Mr. Ford's figures show that there were amongst 90 Siamese cattle 68 deaths, or 75 per cent. mortality; amongst Indian cattle 90 cases with 48 deaths, or 53 per cent. mortality; amongst mixed breeds there were 10 cases with 6 deaths.

On the whole there is more variety in the severity of the disease in the Siamese cattle. These cattle are cheap and can be brought to Kwala Lumpur for some $50 to $60 per head. The Chinese usually feed them well and do not overwork them. The mortality amongst the Chinese owned Siamese cattle was 66 per cent. The Malays and Tamils and Pathans more often neglect and overwork their cattle, and cattle belonging to Europeans are sometimes left entirely in the hands of such employees. Amongst such groups of cattle the mortality was greater. For these figures I am indebted to Mr. Ford.

One complication is the large proportion of cattle that harbour the *Pirosoma bigeminum*. When the cattle are in good health these parasites are only found after a prolonged search, and as none of the Siamese or Indian cattle ever show the ordinary symptoms of Texas Fever (Bovine Malaria) though freely exposed to infection, it is fair to assume that all are ordinarily immune to the effects of the parasites, and that probably nearly all harbour a small number of the parasites. Be this as it may in animals after an attack of Rinderpest these pirosoma are found in much larger numbers and often in much reduced cattle in such large numbers that it is difficult to avoid the conclusion that their multiplication occurring at the end of a serious illness such as Rinderpest is injurious and in part the cause of some of the fatal results.

Post-mortem appearances in fatal cases of Rinderpest in cattle are slight as compared with those in the buffalo. In a fairly typical case all that may be found is congestion of the abomasum duodenum cæcum and rectum with small submucous hæmorrhages in one or more of these places. Ulceration

is exceptional but does occur. The gall-bladder is not affected. The trachea and œsophagus may or may not be injected. Some enlargement of the mesenteric glands is common. In cases where death occurs late, say 9 to 10 days, fatty degeneration of the liver may be found.

The course of the disease in the Bali bullocks resembles that in the Malay buffalo, but the animal is excited rather than depressed. The post-mortem lesions are less marked.

Indian Buffalo.—Though large numbers of Indian buffaloes, about 400, were present in infected districts and even in contact with infected bullocks only 15 adults in all were attacked during the epidemic, and of these all but one recovered though for the first 3 days the symptoms of disease do not differ much from those observed in the other cattle. After this the disease seemed to abort and the animals rapidly recovered. Of some 10 Malay buffaloes in the same district 4 were attacked and all died.

Calves, however, do not show the same degree of immunity and a larger number, 25, were known to be attacked.

An outbreak also occurred in the quarantine shed at Port Swettenham amongst a cargo of 24 Indian buffalo calves, and all were attacked. The mortality was not high, out of the 25 attacked in the Selangor outbreak 12 died, or 48 per cent. and at Port Swettenham 4 died, or 16.6 per cent.

The post-mortem appearances showed changes similar to those in the cattle.

Skin lesions are by some considered to be of diagnostic importance. The discharges from the eyes and rectum frequently cause excoriation. The skin and hair lose their gloss and the coat "stares." A papular eruption is not uncommon but also occurs in healthy cattle.

A herpetic eruption in the mouth is described. Personally I have not seen this, but occasionally the excoriation beneath the branny exudation on the inner aspect of the lips is arranged in points which may be remnants of ruptured vesicles.

In buffaloes there is often an intensification of the redness natural on the inner aspect of the thighs and near the genitalia. This redness is not only more intense but deeper in colour, and in the last stages exudations may occur. The natives, I find, attach great importance to this change in colour for diagnostic purposes, and so do some Europeans of experience. I did not consider the change which does occur to be sufficiently marked to be of much value.

As regards the diagnosis of the disease in isolated cases or at the commencement of an outbreak this may be difficult. In many of its clinical aspects there is a suspiciously close resemblance to some of the outbreaks described as *Hæmorrhagic Septicæmia*, and as the local swellings which are a feature of that disease may not be present the absence of such swellings is no proof that the disease is not *Hæmorrhagic Septicæmia*.

In *Hæmorrhagic Septicæmia*, however, a characteristic organism is found in the blood, glands, etc. In the outbreaks here considered numerous animals either killed in various stages of the disease or immediately after natural death from the disease were examined. In none of these were these organisms found in any of the tissues or fluids of the body, and inoculation of various media with these fluids, with scrapings from the glands, liver, spleen, etc., were barren, with the exception of a rare contamination from skin or air organisms.

Moreover certain animals, rabbits and guinea pigs, are highly susceptible to Hæmorrhagic Septicæmia and immune to Rinderpest. The blood and scrapings from the glands of cattle with the disease were injected either subcutaneously or intraperitoneally into 12 rabbits and 14 guinea pigs, and in no case were these animals infected.

In cases where the cattle or buffaloes had been dead for some hours the results of injection were uncertain and some of the injected animals died, but even in these cases the organisms found in the tissues and fluids of the dead rabbits or guinea pigs were not those of *Hæmorrhagic Septicæmia*, and the organisms obtained in such cases from the blood or serum of the cattle varied in different cases and could usually be identified as organisms commonly met with in the early stages of putrefaction. The organisms recovered from the blood or tissues of the animals in no case were those of *Hæmorrhagic Septicæmia.*

The outbreaks at Port Swettenham and Kwala Lumpur were the ones investigated bacteriologically, and the negative evidence against the disease being *Hæmorrhagic Septicæmia* was conclusive.

At Dusan Tua the buffaloes had been dead for some hours, and though the injection of blood was fatal to the smaller rodents and organisms were obtained by culture from the blood of these animals the organisms isolated either from the direct cultures or after passing through the small rodents were not those of *Hæmorrhagic Septicæmia.*

All attempts at finding any organism, animal or vegetable, bacterial or protozoal, to which the causation of the disease could be assigned have failed. The frequent presence of Pirosoma in cattle and in one buffalo only of a trypansome were merely examples of concurrent diseases.

The course of the outbreaks and the manner in which the disease spreads is of great practical importance, as on the knowledge of such factors measures for the prevention must be based.

It may be stated at the outset that though there is evidence that wild pig and some domesticated pigs get the disease and that it is probable that other game, particularly the Sladang, may do so. No part seems to have been played by these animals in the spread of the Selangor outbreaks. No spread could be traced to goats and no cases occurred amongst the goats, nor was I successful in artificially by inoculation transmitting the disease to goats. I am aware that in some outbreaks of Rinderpest some breeds of goats have been proved to be susceptible.

For all practical purposes in Selangor the disease can be considered as one transmitted from Cattle or Buffaloes to Buffaloes or Cattle directly or through the medium of fairly fresh discharges from diseased animals.

The disease is not endemic and districts may remain for years free from the disease. When imported, however, it rapidly spreads unless active measures are taken to prevent the spread of infection. Though not endemic it is rare to find all parts of the Malay Peninsula free from the disease at any one time, and cattle are also imported from India, Siam, and the Malay Archipelago, and kept for a variable period at Singapore or Penang. Through these Cattle the disease is, from time to time, re-introduced. In Selangor in the period under review there were five definite importations of the disease.

Two of these were detected and stopped at Port Swettenham, viz., one amongst Malay buffaloes in November, 1903, and one amongst Indian buffalo calves in June, 1904. Two other importations were unfortunately not detected at Port Swettenham but were seen amongst the recently

imported cattle at Kwala Selangor and Kwala Lumpur respectively, and to these two importations the two epidemics, the outbreaks at Kwala Selangor, Kwala Lumpur, and their environs, were directly referable.

The other outbreak, August, 1903, occurred in various small stations along the Seremban Road, the main road from Negri Sembilan to Kwala Lumpur, and was probably due to the importation of mildly diseased cattle viâ the unprotected port of Negri Sembilan, Port Dickson.

Each time the disease was discovered at Port Swettenham the cases were detained at the Quarantine Station, and though it spread to other animals in that station there was no extension of the disease outside.

On the two occasions in which the disease was not detected at Port Swettenham it spread more widely, and cattle and buffaloes long resident in or native to the country were in time attacked. Owing to the energetic measures adopted by the Government Veterinary Surgeon, though the loss was heavy, the epidemics were localised and did not involve any extensive area.

The outbreak along the Seremban road was fortunately through a country where cattle and buffaloes were not numerous. There were three separate places infected when the outbreak was discovered at the 8th, 12th and 21st miles respectively. The roads were closed, the cattle isolated and some of the diseased shot and this epidemic was soon stamped out with a loss of 7 buffaloes and 7 bullocks.

It will be seen from the detailed account of some of the outbreaks not only that the disease is imported but that the local spread from any focus is due to direct spread by cattle and to causes preventible in the sense that human care and intelligence with moderate expenditure of money can prevent them.

It is not pandemic, nor widely diffused in earth, air or water. Each case can be traced to a preceding case and a probable means of transfer pointed out and often proved.

History of the first Port Swettenham Outbreak.—A cargo of 30 Siamese buffaloes arrived at Port Swettenham on November 6th, 1903, by S.S. "*Pulau Rimau*." The buffaloes had been for 20 days at Province Wellesley. They were placed in the quarantine sheds and one died on November 10th. On the 11th two were found to be suffering from Rinderpest and were shot. On the 13th, 15th, 16th and 17th, there were respectively 4, 1, 6 and 3 cases, and the remainder were attacked by the 19th.

Others who had not shown any sign of disease had been killed for meat before this date.

In the Quarantine Station there were in other sheds 30 Siamese bullocks. None of these were attacked till November 22nd, 12 days after the first death and probably 16 days after the first infection of the station, a period to be noted as more than twice the period of incubation for these animals for this disease and, therefore, indicating that during at least half this period, over a week, there was no spread of infection to animals in adjoining sheds some 30 feet away from the shed in which the infected buffaloes were kept.

Between 22nd and 24th of November all these bullocks were attacked, proving a common source of infection between November 16th and 19th. The probable source of this general infection was not difficult to trace as during this period there were high tides and a faulty self-acting valve allowed the water in the drains to be backed up into the station and so

flooded the entire station. As these drains received the washings of the infected shed and much of the excreta of the diseased buffaloes the conditions necessary for the general infection which occurred were present.

The possibility of the disease having been conveyed by the attendants, buckets, etc., exists, but would not probably have caused so sudden and general a diffusion of the infection.

Kwala Selangor Outbreak.—I had no opportunity of inspecting this outbreak, but Mr. FORD informs me that the first death was on or about January 10th to 12th, and the second 12th to 14th, amongst a shipment of eleven Indian calves which left Penang on January 2nd. As the existence of Rinderpest in Penang had not been notified they were not placed in quarantine at Port Swettenham, but marched direct overland, a journey of 2 to 3 days. As will be seen from the dates of death the two first cases must then have been in the period of incubation. If they had been quarantined for the usual period of 10 days as they would have been if information of the outbreak in Penang had been given the disease in this severe form could hardly have been overlooked even with the imperfect supervision then exercised.

That the infection took place at Penang, not on board ship, is probable, as 18 buffaloes imported at the same time in the same boat were not infected.

A few days after this second death a local bullock died and after this the disease occurred amongst other local animals as well as amongst 3 other of the imported calves. In all there were 47 deaths before the epidemic was stamped out, and 23 of these were calves.

Cases occurred not only at the original focus where the imported calves were attacked but at two stations along the road 2 and $3\frac{1}{2}$ miles respectively from this place.

To both of these places the transfer of cattle between the period from the outbreak of the disease, about January 6th, to its notification on February 8th, were definitely traced.

The Kwala Lumpur outbreak occurred immediately after the Kwala Selangor one, but was only related to it in that it was also introduced by a cargo of Indian bullocks from Penang, then known as a result of enquiries made in connection with the Kwala Selangor outbreak to be an infected port. These 15 cattle left Penang by S.S. "*Pulau Rimau*" and arrived at Port Swettenham on February 3rd. They were detained at the Quarantine Station till February 13th, and were inspected at Kwala Lumpur on February 15th by the Veterinary Inspector. There were no deaths at the Quarantine Station and no illness was reported, but as there was at that time no skilled supervision at the Quarantine Station a mild attack might easily have escaped notice. On February 21st at Kwala Lumpur one of these animals died and the owner next day reported the death. On examining the animals on the 22nd, one was definitely suffering from Rinderpest, but in the late stage, say sixth or seventh day, just after the temperature has fallen but with some of the symptoms still marked. Two other animals of the same batch presented symptoms of the mild form of the disease at about the same period. These three animals rapidly recovered, but though subsequently freely exposed to infection none of them developed the disease, thus confirming the preliminary diagnosis. As the usual period of death in Indian bullocks is the sixth or seventh day, as the other three animals were in the stage that is usual in mild attacks about the seventh day, it is probable that the onset in all four cases was on or about the 15th of February, and as

temperatures were not taken, there would be nothing at the inspection on that date to show that the animals were ill even if at the time of inspection the disease had commenced. It is to be noted that during the period from February 15th to February 22nd during which these animals sickened there was nothing to prevent the spread of infection and the wide distribution of animals in contact with these diseased ones. Later proof was obtained that some animals from the shed had been sold and taken to a place where they developed the disease and acted as foci for other outbreaks.

The three living animals with the disease were immediately isolated, and the remaining eleven of the imported cattle were also isolated and another group of 22, which were in stalls sufficiently close for the possibility of infection to have occurred, separately isolated, and all movements in and out of an area of about two square miles were prohibited. The cattle in this area, numbering some 250, were inspected daily and kept tied up. No further cases occurred amongst the cattle except amongst those which had formed a part of the first shipment. Amongst these 2 cases occurred on the 25th. The remaining 10 of this group which were free from any sign of the disease were taken to the Institute and kept in the veterinary enclosure. One case amongst these occurred on the 28th, one on March 1st, and one each on the 11th and 13th. Some attempt at isolation was made in that as soon as any animal was attacked it was kept separate, but the space available was not sufficient for complete isolation. Even the imperfect attempt was partly successful as 6 were not attacked and 2 of them were proved to be susceptible as they subsequently acquired the disease in a later outbreak.

It appeared, therefore, that the epidemic had been stamped out in a cattle district by simple means and with a loss of only 4 head out of 10 attacked.

After the attack had been recognised, except amongst the original herd, there were no fresh cases in that district for some months, and this herd was so isolated that no spread to other cattle took place.

In spite of this two fresh outbreak, about 3 and 5 miles respectively from the site of the original outbreaks, were discovered on February 27th and March 15th respectively. Subsequently it was ascertained that cattle from the originally infected area had been sent to these places just before that outbreak had been reported but during the period when the original four animals were suffering from the disease. Two fresh foci were thus formed. At both these places the ground is irregular and full of holes from old tin mines and brickfields. The cattle sheds were built on the elevated portions and in the hollows between the animals grazed and were washed and the drainage from the sheds naturally passed into these hollows.

Proper isolation in this district was impossible. The cattle showing no signs of the disease were removed to temporary quarantine stations and inoculated with Indian Rinderpest Serum.

In one of these two outbreaks when reported, February 27th, one animal was found dead and one was attacked in the next week. There had been a death, cause unknown, February 21th.

The second outbreak was reported on March 15th, and four animals were then suffering from Rinderpest, and by the 17th, four more were down with the disease.

From these localities, during the period before they were discovered, cattle were moved and fresh foci established, and for some months fresh outbreaks were discovered almost every week. The natives, particularly those from India, did not report cases at all or until a death had occurred, and in some cases outbreaks were only detected by the discovery of a freshly buried animal, anonymous letters, etc.

In nearly all isolated outbreaks the origin of the disease could be traced to the movement of cattle from an infected place previous to the discovery of that infection.

One series of outbreaks was directly referable to cattle being allowed to graze on land on which infected cattle were or had been grazing. A large number of bullock carts were required in connection with the railway workshop at Batu Road 3rd mile. Near this place was an early infected district, and, in spite of strict orders to the contrary, when carts were unloaded bullocks were often allowed to graze freely on this ground, and amongst groups of these cattle the disease occurred.

The furthest places from Kwala Lumpur to which the disease spread were Cheras, 10th mile, Dusun Tua, 17 mile, and Kuchai, 15th mile. In these places comparatively early information of the outbreaks was received, and the disease remained limited to the group of animals amongst which it originated. The infection in two cases could be traced to the movement of one or more cattle from an infected area in Kwala Lumpur.

It was satisfactory to find at Dusun Tua that the inhabitants themselves discovered the outbreak and its source, gave the necessary information and had rigidly confined their own cattle on their own responsibility. No further spread of the disease took place from these centres.

As a general result each of the numerous outbreaks were, as outbreaks, quickly suppressed, but in the majority of cases sufficiently early information was not obtained and infected cattle in the incubation stage had been moved elsewhere and so started fresh outbreaks. Little help can be obtained from the Indian natives, and information as to these transfers was only obtained after the fresh outbreaks. The people concerned in the transfer invariably deny that any cattle have been transferred, and the proof that they have is only to be obtained indirectly subsequently. The great majority of the cases, 209 out of 245, in which the ownership was noted were in cattle belonging to natives of India.

All the evidence points to a comparatively short diffusion of the virus in air under the ordinary conditions. There were cattle grazing within 40 yards of the veterinary reserve at the Institute where cattle with Rinderpest were confined. None of these acquired the disease. A few cattle confined for over a month in and near a shed within this reserve did not acquire the disease, though other cattle in a shed 25 yards off were, during that period, in the acute stages of the disease. Not only as already mentioned in the outbreak at the quarantine station did infection not take place for over a week from a shed some 30 feet distant, but even of the buffaloes in the same long shed more than one-third did not get the disease for over two weeks, showing that no infection had been acquired by them for at least one week. It is also noteworthy that of animals confined in the same shed that if isolated from each other a considerable proportion escape infection and those that become infected are often the pairs that work together. Out of one batch of 20, two pairs escaped infection altogether, and only one other animal, whilst of the remaining 15, in 4 pairs both animals were attacked on the

same day, and in 3 other pairs there was an interval of 5 or 6 days between the onset of the attack in the two animals, i.e., one had infected the other. Considering the opportunities in a cattle shed for fouling of beds and fodder and the dissemination, when the sheds are flushed, of discharges from a diseased animal, it is open to question whether the disease is conveyed at all through the air or whether it is not always conveyed by the infective discharges.

A good deal of the confusion that arises in the comparison of the effects of serum inoculation, etc., is due to differences of opinion as to what constitutes effective "contact."

Theoretically "contacts" are animals which have been exposed to infection, but experience shows that even of a herd where the exposure to the possibility of infection has been considerable only a few animals are infected, though these may subsequently infect the entire herd, and in other instances where apparently there has been exposure to infection of susceptible animals none of them are attacked.

In considering the value of serum, as we know that it has no effect in preventing the occurrence of disease in animals already infected, I take as the test of effective contact the occurrence of cases of Rinderpest in a herd within 10 days of injection, i.e., 7 days for incubation and 3 days for the obvious symptoms to become apparent. Where routine temperatures are taken I should shorten this period to 8 days.

It is known that all the discharges of a diseased animal are capable of carrying the disease and that the virus is not retained in the discharges or blood of the animal for long. The question of the length of time that a shed or pasture will remain infected is of practical importance. Experiments with the virus, *in vitrio*, are not conclusive, as the natural conditions differ. Though no direct experiments were made it was considered better, in cases of certain groups of cattle doubtfully contacts, to send them to the Institute in preference to sending them to the quarantine station where infection was almost certain. No cases developed amongst these groups, though in one case the cattle were grazing over the same ground and occupying the same sheds that had been used for cattle with Rinderpest a month previously, so that even under natural conditions it appears that in this country the virus is destroyed in less than one month.

On theoretical grounds it is certain that the disease can be conveyed by man directly conveying on his clothes, person or utensils, in fodder or in bedding, the discharges of a diseased animal to a healthy one. I believe from what I have seen of the carelessness of natives that the disease is often conveyed in this manner from one animal to another of the same herd. Even in taking temperatures there is difficulty in preventing this mode of infection. Although for short distances this is probably a fertile source of infection there was no instance in these outbreaks in which it appeared probable that the disease had been carried by man to any considerable distance, or that any other cause but the transfer of cattle was the origin of any outbreak.

Mr. Ford informs me, however, that in a previous epidemic a Malay cattle witch, *bomor*, after charming a diseased herd conveyed the infection about $3\frac{1}{2}$ miles to her own herd. In that case there had certainly been no transfer of cattle.

The class of animals dangerous as carriers of the disease is important. We know that mild attacks are fertile sources of infection, the more so that

attacks may be so mild that the animal may only appear to be in ill health for a day or two and may be able to travel and even to work throughout the illness. These animals, usually Indian bullocks, are the most dangerous carriers, more so than the Malay buffalo which is usually unfit to travel before the discharges are abundant. These animals show little disposition to travel and are so markedly ill that the disease is at once detected.

Indian Buffalo calves were possibly carriers amongst the adjoining herds of cattle at the 2nd mile Batu Road.

We have no proof how long convalescents can carry infection. No case of infection could be traced to any of the convalescents discharged. Careful watch was maintained. Only few convalescents were allowed out of isolation in three weeks, and the majority were kept over a month, often much more than a month, so that a convalescent does not convey the disease more than three weeks after convalescence.

Prophylactic use of Serum.—Inoculation with serum prepared locally and inoculation combined with simultaneous injection of virulent blood had been tried in previous epidemics. The results had not been sufficiently conclusive to cause the general adoption of either method.

There are considerable difficulties in the local preparation of serum, and considering the high price of cattle and the expense of a staff for serum work it was considered cheaper and better to import serum from India.

Mr. Moir, the Government Veterinary Surgeon, Perak, had been using this serum for some time and considered his results as highly satisfactory.

Mr. Ford, the Government Veterinary Surgeon, Selangor, first used this serum in the Kwala Selangor outbreak and to a very large extent in the Kwala Lumpur outbreak. His earlier results seemed to indicate: (1) The cattle already infected had the disease in a milder form and that the percentage of recoveries were higher; (2) That animals inoculated previous to exposure to infection or which were not already infected did not become infected.

As regards the first of these the more extensive knowledge now gained shows that the serum does not appreciably mitigate the severity of the disease either in animals infected or in the stage of incubation, and that there is no appreciable reduction in the mortality.

As regards the second, with numerous provisoes and exceptions, it holds good for a limited period only.

With Indian bullocks out of 771 of those injected 54 cases, or 7.4 per cent., occurred over 10 days after injection though most of them were exposed to infection in the next two months.

The Siamese bullocks gave similar results. Not only as with the Indian bullocks did it have no effect if injected into animals already infected or in the incubation stage, but practically the same proportion, 39 out of 610, of those injected developed the disease more than 10 days after the injection and, therefore, had received the injection before infection occurred. Double the proportional dose was given with the Siamese cattle, as in the minimum with some groups the effect was so slight, but even with this dose though protection seemed to be conferred on some lots of cattle on others it was comparatively slight.

It appears that Siamese cattle, really cattle from widely scattered countries, vary greatly as to their susceptibility.

The effect of inoculation is illustrated by a comparison of the period which elapsed after removal from contact of an injected and non-injected herd. The injected herd were injected with double the minimum dose of serum the day they were removed from contact. The date of onset of the disease in both groups was determined by the rise of temperature.

Non-injected Herd.—Cases developed on the 4th, 6th, 15th and 17th days and 3 months later from fresh infection.

Injected Herd.—Cases developed on the 2nd, 3rd, 5th and 6th days and none later. In both groups the "contact" extended over a period of some days.

With Malay buffaloes the susceptibility is so great that small doses were obviously useless. A young Malay buffalo was given 10 times the proportional dose usually sufficient for protection with Siamese cattle and 20 times that which suffices for Indian cattle and the beast was then exposed to infection. It developed the disease in 5 days and died after 3 days illness. The same proportional dose was subsequently used by Mr. Ford for full grown buffaloes and no immunity resulted.

Though the value of the serum is limited it is still great, and simplifies the problem of dealing with an epidemic. By the use of serum in efficient doses only those cattle already infected and in the incubation stage are attacked, the others escape. The period of quarantine required is shortened, as with each fresh case a fresh period of quarantine would be required dating from the time of removal from contact with the diseased animal. Animals so protected are less liable to contract and, therefore, to convey the disease than animals unprotected.

Prevention.—The number of cattle imported at the various ports in the Federated Malay States per annum is some 2,000 cattle and about 5,000 buffaloes. Many others brought from a distance are landed at Straits Settlements ports, Malacca, and Prai, and marched overland into the Federated Malay States. Cattle are also marched across both the Northern and Southern boundaries. Effectual quarantine would, therefore, appear to be impossible, and on quarantine alone without provision for dealing with outbreaks occurring inland reliance cannot be placed.

The fact, however, remains, that two outbreaks were stopped at the quarantine station, and that with effective supervision at the port two others would probably have been stopped, and that one of these would have been stopped if notification of the disease in the great distributing port of Penang had been enforced.

Quarantine has been of value, and more thoroughly carried out would be of greater. As, however, the expense of large quarantine stations is considerable, and that without a thoroughly competent veterinary inspector are only of uncertain use, the advisability of limiting the number of ports at which bullocks can be imported is worthy of consideration.

Inoculation with serum at Penang and Singapore would reduce the risk of importation but not prevent it.

The main reliance after quarantine, in my opinion, must be on internal administration. Quarantine is valuable but at times must fail.

It is, I hope, clear that in these epidemics the difficulty in preventing the spread of the disease once it is introduced is the absence of early notification of the disease and the impossibility of ascertaining what transfers of cattle have been made.

As agents in spreading the disease the Malay buffaloes are less important than the bullocks, because they so rapidly become seriously affected and incapable of travel, and also on account of the shorter duration of their illness.

As regards both early notification of disease and knowledge of transfers of cattle much more supervision of the cattle sheds than is at present possible is necessary. Whether this is done by a Veterinary Police Force, by more numerous Veterinary Inspectors, or in what other way is, of course, an administrative matter, but it is essential that such supervision should be exercised habitually and not spasmodically on the occasion of an epidemic.

The Veterinary Staff for the two States, Selangor, 3,200 square miles, and Negri Sembilan, 2,600 square miles, consists of one Veterinary Surgeon for the two States. There is also one native Veterinary Inspector for Selangor.

The assistance of Sanitary Inspectors, Hospital Dressers, etc., can sometimes be obtained when there is any outbreak of disease, and others can under the same circumstances be engaged as temporary watchmen.

For practical purposes so small a skilled staff supplemented by unskilled auxiliaries is less efficient than a large trained staff would be, and in the long run less economical.

A system of registration of cattle and of the owners of cattle would enable an outbreak to be rapidly suppressed. This system if applied only to cattle and not to buffaloes would not be difficult to enforce and would enable any transfers to be followed. With such a system branding of the horns of adult cattle low down would probably be required.

If any fee were charged for such registration it should be small, as the object would not be for revenue but for the protection of cattle and their owners.

With any effective provision for early information of disease and of transfers from diseased herds I am of opinion that no serious spread of Rinderpest would take place even if the disease were frequently imported.

To deal with an outbreak rigid isolation of all diseased and certain contacts is necessary. The question of shooting such animals is raised with each outbreak and must be decided on according to circumstances. In the Kwala Lumpur outbreak the matter was considered. The Veterinary Surgeon was then away at Kwala Selangor dealing with the outbreak there, and in his absence my opinion was taken by the acting Health Officer. I decided against shooting either the diseased or contacts on the grounds that these animals could be satisfactorily isolated and spread of the disease from them prevented for the future, and that as the animals had been ill for some days probably infection had already been spread. That further outbreaks were probable and that the effect of shooting these convalescent animals would be to discourage the early notification of the disease for which we hoped. Our hopes were not fulfilled to any great extent, as few outbreaks were notified early, but as events showed shooting these animals would not have prevented or limited the outbreak.

The question of compensation for the destruction of animals is a difficult one. No doubt if full compensation were given for the destruction of animals earlier voluntary notification would take place, but I do not think that payment of compensation would make people more careful in preventing the spread of the disease, the expense to the State would be great, and

increased supervision and registration would serve the same purpose in a sounder manner and at less cost. Special cases, such as cases early in an outbreak, might, I think, receive special consideration, and an owner who reports early the first cases in an outbreak might be rewarded by full compensation for his losses or otherwise. The penalties for concealment of cases should be rigidly enforced, a minimum as well as maximum fine specified, and an informer should receive a portion of the fine.

The principle in isolating cattle in an outbreak should be to move the apparently healthy cattle from the sick ones and their surroundings, not the removal of the sick cattle. With each fresh case the herd should be moved and, as far as possible, subdivided into small groups. In this manner a large proportion of a herd will escape. Naturally this can only be done where there is abundant space, and then requires the erection of temporary sheds.

Removal of diseased cattle and thoroughly cleansing and disinfecting the sheds is less effective, but if the other method is impracticable is of some use.

The use of serum, as already pointed out, in effective doses should limit the spread of the disease to the cattle infected at the time of injection. In a future outbreak I think larger doses both for Indian and Siamese cattle should be used, even if this necessitates limiting the injection to actual contacts.

The universal inoculation with serum and either simultaneously or shortly after injecting with virulent blood is, in my opinion, impracticable in this country at present. It can only be practised during the occasional occurrence of Rinderpest, as virulent blood cannot be preserved. The doses of serum required for Malay buffaloes must be large, and for the various mixed breeds and for the cattle from various parts of the country are uncertain.

There would be serious risk that the disease might be widely disseminated by the method and that many of the protective inoculations would fail and that the mortality amongst those injected would be large.

The actual loss to the State and people of Selangor cannot be estimated only by the deaths amongst the animals. These were 350 to 400, of a value of some $40,000 or less. For one animal that died at least two were prevented from working for say two months, and the loss in earnings of these cattle, in wages of grass cutters, attendants, etc., was considerable. A serious loss to the public was the delay and inconvenience caused to public and private work by the necessary closing of roads and interference with cartage and traffic. The rise in the price of cattle and cartage has been considerable.

With the extensive clearings that now exist in various parts of the country there is no reason but the occurrence of these epidemics why cattle raising on both a small and a large scale should not be remunerative. The successful raising of stock would benefit the country, and the cessation of the large import trade in cattle diminish the risk of the introduction of the disease.

To conclude.—The disease is one which has been and probably will be imported from time to time, usually by sea. Some, perhaps the greater number, of these importations are preventable. If early notification of cases and early information of movements of cattle can be obtained even when the disease is imported its spread should be easily restricted and the direct losses from the disease small. For such a result a permanent annual expenditure for increased supervision would be requisite.

Note on Hydrophobia in Selangor, 1903 and 1904.

In a report by Dr. W. L. Braddon, State Surgeon, Negri Sembilan, on "*Rabies of an Indefinite Character amongst Dogs*," February 24th, 1902, an account is given of a small outbreak of this disease, and he concludes that: "(1) Dogs may have true rabies and yet exhibit no signs of illness by which the malady can be certainly diagnosed."

During the years 1903 and 1904, a considerable number of dogs, some alive and some dead, have been sent to the Institute to determine whether or not they had rabies.

The living animals were kept in a large cage and watched carefully. From the dead animals intradural injections of cerebral-spinal matter from the medulla were made into rabbits and, where possible, a history of the dogs was obtained.

The result of the observations is to confirm Dr. Braddon's result that the type of rabies in this country is atypical. Occasionally a typical case occurs.

In all twenty dogs were investigated at the Institute. Eight dogs were sent alive to the Institute but 3 of these were not cases of rabies, and after being kept for one or more weeks were returned to the owner.

In addition to the 5 cases under observation at the Institute one other was under observation outside. Twelve dogs were sent in dead suspected of having rabies; 6 of these had been killed and 6 had died naturally. Many of these bodies were more or less decomposed, and as a result of this decomposition in 3 cases rabbits injected from them died within 48 hours of septicæmia, thus vitiating the experiment so that no certainty was possible.

In 4 other cases the rabbits showed no symptoms and recovered completely, so that rabies could be excluded. In one case no rabbits were available.

Excluding these there were 9 cases of rabies as proved by post-mortem examinations and intradural injection of medullary substance from the dog.

Of these cases 2 occurred in July, and in the same month, but rather later, 2 cases occurred, one of the violent type of rabies and one of the paralytic form, in dogs outside and were certified as rabies by the Veterinary Surgeon who had seen them.

The next cases were in September, 1904, on the 15th and 21st respectively, and there were 3 cases in October, and one each in November and December and in January, 1905.

The other dogs who either recovered or in which no symptoms of rabies developed in injected rabbits were sent up both during the period when the cases of rabies occurred and in the intervening period.

In the case described by Dr. Braddon, a dog at large snapped at and bit a child, several dogs, and some goats. The dog had a few days previously been bitten by a snake, and it had been noticed that it had little appetite but had shown none of the mental change, alteration of disposition and demeanour usually described. On the following day the dog, though rather dull in demeanour and poor in condition, was perfectly tractable and obedient. It could be handled and showed no signs of irritability. There

was no excess of saliva in the mouth, and no appearance of weakness or loss of control over movement. The appetite was poor, but there was no difficulty in swallowing. No more definite signs supervened, but next evening it refused food and died on the following morning, 3 days after its short period of excitement.

The diagnosis of rabies was shown to be the correct one by the result of intradural injection into a rabbit by Dr. BRADDON, and subsequently at the Institute Pasteur de Saigon by injections from a portion of the brain of the dog sent there by Dr. BRADDON.

In the cases under observation similar deviations from the usually described forms of the disease occurred. In only one was there excess of saliva discharged from the mouth. In only one was there definite paralysis. The stage of excitement in most of them had probably been manifested before admission as the dogs had bitten other dogs or people but was either not present whilst under observation or was only present during a brief period which in two cases was late in the disease on the day of death, and in another on the third day over 24 hours before death. Loss of appetite, complete before death, was the only constant symptom. Death occurred in all cases and in from 3 to 5 days after the animal was first suspected of being ill. Several of the other dogs under observation showed more violent dispositions than those dogs shown to have rabies.

The diagnostic value of intradural injections was clearly shown. There are difficulties connected with it, as rabbits in the tropics appear more liable to disease, do not breed so fast, and are more difficult to rear than in temperate climates. Putrefaction is so rapid that unless a dog has been killed or died within a few hours of the examination the rabbits injected frequently die of septicæmia.

The virus of hydrophobia appears to be in a somewhat attenuated form in Malaya. The usual period of death after intradural injection in the rabbit was 17 to 18 days, and the earliest 15 days. As in Europe, the virus is intensified in passing through the rabbit, and the period after an intradural injection from one rabbit into a second rabbit was reduced to 12 to 14 days. Third injections were not performed on account of the scarcity of male rabbits.

A point of importance is the small number of cases in which the dogs bitten developed rabies. Out of a considerable number believed or known to have been bitten by these rabid dogs only 4 are known to have in turn become rabid, and the others, many of them under careful observation, have shown no signs of the disease. Of the four who developed the disease after being bitten by rabid dogs in two the period was rather short, 20 and 25 days respectively.

None of the human beings bitten by the dogs have developed rabies. Most of them were sent to the Pasteur Institute, Saigon, for treatment.

The rarity of the cases in which dogs bitten by the rabid dogs developed rabies may be due to the usual absence of salivation in the local variety of rabies. It is noteworthy that at the post-mortem examinations on the rabid dogs no marked enlargement or congestion of the salivary glands was found.

Whether rabies is endemic or not amongst dogs in the country cannot be stated. The occasional appearance of a group of cases with a long interval between, favours the supposition that it is not endemic, but imported

from time to time, but none of the diseased dogs had been recently imported. The jackal, the probable source of rabies in India, is not present in this country, and though no doubt carnivorous animals susceptible to the disease in its violent form exist in the country, there is little probability of dogs being infected by their bites. The Musang (Civet Cat) may possibly carry the disease in some cases.

A more rigid enforcement of the licensing enactments and destruction of unlicensed pariah dogs would, in my opinion, render the outbreaks less frequent and less prolonged. In the event of an increased Veterinary Staff or of a Veterinary Police Force this enforcement would naturally form a part of their duties.

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